APPENDIX D. Development of Power Curves for Bradford Island Fish Sampling Program

In support of the study design for the fish tissue sampling for Smallmouth bass, historical data from Forebay and Reference area were used to generate power curves. The power curves provide a basis for determining the number of samples that will be needed to compare the Forebay to a reference condition (whether that be a reference area mean or a comparison value). Note that in the current design, each data point will represent a single, whole fish.

Historical data for Total PCBs from the 2011 fish sampling effort and from the 2006 and 2008 sampling effort were used to provide input data for the power analysis. This included the mean, standard deviation (SD), and sample numbers (n) (Table 1). The complete data sets were used from the reference area. The Forebay datasets from both 2006 and 2011 included data points that were extremely high (>19,000 µg/kg Total PCBs). These data points were considered outliers and were removed from the data set for the purposes of this analysis, since the variability would result in very high estimates of standard error and very low estimates of power. If these high concentrations are still present in fish tissue, decisions are not likely to be made based on statistical analysis. Summary statistics are presented in Table 1.The distribution of Total PCB tissue concentrations for each of the data sets is presented in Figure 1.

Table 1. Data Sets Used for Power Curves

Location	Year	Mean (µg/kg Total PCBs)	SD	n	Range (µg/kg Total PCBs)
Reference	2011	63	87	19	17-407
Reference	2008	82	106	19	22-499
Forebay Censored	2011	55	65	13	13-277
Forebay Censored	2006	593	764	17	32-2482
2011 Reference and Forebay Censored Combined	2011	60	77	34	13-407
Forebay Combined High Values Censored	2006 - 2011	341	614	32	13-2482

- Censored values have highest values removed (all values >19,000 µg/kg)

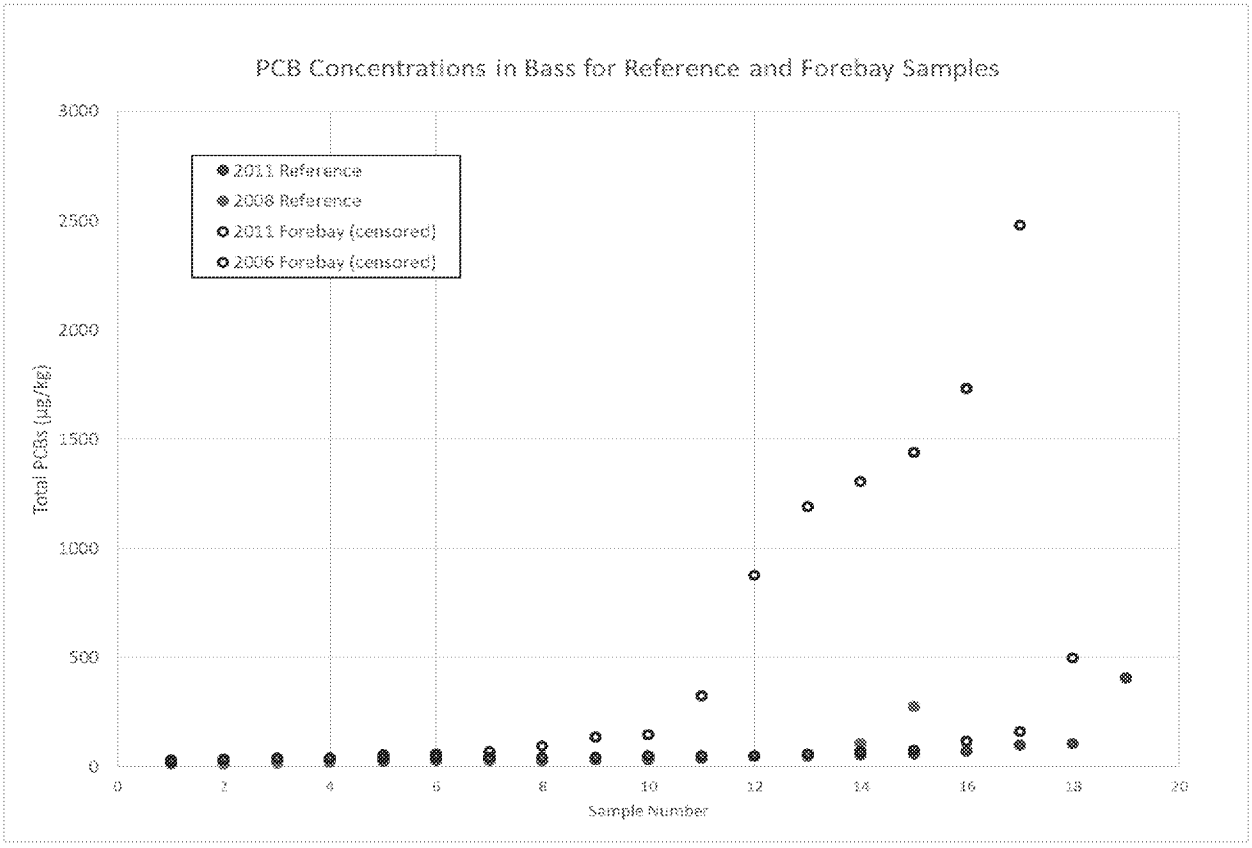

Figure 1. Distribution of Reference and Forebay Data Used in Power Analysis

For the purposes of the upcoming sampling, two power curves were generated. The first was intended to support a comparison between the Forebay and Reference. The second was to represent a more variable data set in the Forebay compared to a threshold concentration.

Scenario 1: Forebay 1 vs Reference

The reference mean was based on the 2011 Reference data. The Reference area mean of 63 µg/kg is similar to the 2011 censored data set for the Forebay without the extremely high values (mean = 55 µg/kg; SD: 77 µg/kg).

The treatment mean for this scenario, Forebay 1, (100 µg/kg) was an estimated low-end value that we would need to distinguish from Reference. This would represent a condition where the fish tissue concentrations were similar to 2011 in the absence of the extremely high values observed in 2011. This estimated value was also the 95% UCL for the reference data indicating that the number of samples should be sufficient to distinguish between reference and a value above the 95% UCL (100 µg/kg).

The Standard Deviation (77 µg/kg) used in this scenario was based on the combined 2011 Reference and 2011 Forebay Censored dataset. There was substantial overlap of these two data sets that appear to represent the Reference condition and provided an estimate of variation for a population of 34 fish. While this dataset did include all fish from the reference area (e.g. one value of 407 µg/kg), it provided a conservative level of variation that might represent a future condition. In other words, the data is further processed to remove values certain values, the estimate of power might be overestimated and the number of samples needed might be underestimated.

Input Information for Curve 1:

Hypothesis: Is mean PCB tissue concentration in Smallmouth bass from the Forebay significantly different from the Reference?

Reference Mean: 63 µg/kg (based on 2011 Reference data)

Forebay Mean: 100 µg/kg (estimated value; 2011 Reference 95% UCL)

Standard Deviation: 77 µg/kg (based on 2011 Forebay data set w/o 4 points (>30,000 µg/kg)

Alpha = 0.05

Scenario 2: Forebay 2 vs Reference

The reference mean for this scenario was based on the 2011 Reference data and was the same value used in Scenario 1.

For this scenario, the Forebay 2 mean (341 µg/kg) and standard deviation (614 µg/kg) were based on Total PCB concentrations from the Forebay in 2006 and 2011, with the highest values (>19,000 µg/kg) removed. This data provided higher mean and standard deviation scenario, and might represent a future Forebay data set that includes intermediately elevated fish tissue concentrations (500 to 5,000 µg/kg PCB).

Input Information for Curve 2:

Hypothesis: Is mean PCB tissue concentration in Smallmouth bass from the Forebay significantly different from the Reference?

Reference Mean: 63 µg/kg (based on 2011 Reference Mean)

Forebay Mean: 341 µg/kg (combined 2006/2011 Forebay data without six points (>19,000 µg/kg))

Standard Deviation: 614 µg/kg (based on combined 2006 and 2011 Forebay data set without six points (>19,000 µg/kg)

Alpha = 0.05

Curve 3: Forebay vs Critical Value

A critical tissue value as a point of reference has been proposed in lieu of using a reference-based sample. For the purpose of this power analysis, the critical tissue value was 100 µg/kg, based on a No Observed Adverse Effects Level proposed by USFWS. The value that is ultimately used for the site may differ.

For this power curve, the Forebay mean (341 µg/kg) and standard deviation (614 µg/kg) were based on Total PCB concentrations from the Forebay in 2006 and 2011, with the highest values (>19,000 µg/kg) removed. This data provided higher mean and standard deviation, and might represent a future Forebay data set that includes intermediately elevated fish tissue concentrations (500 to 5,000 µg/kg Total PCBs).

Input Information for Curve 3:

Hypothesis: is mean in Forebay significantly different from a Threshold of 100 µg/kg.

Historical Mean: 100 µg/kg (based on 2011 Reference mean)

Forebay Mean: 341 µg/kg (based on combined 2006 and 2011 Forebay mean without six points (>19,000 µg/kg)

Standard Deviation: 614 µg/kg (based on combined 2006 and 2011 Forebay mean without six points (>19,000 µg/kg)

Alpha = 0.05

The three power curves are shown on Figure 2. The power curves show the number of samples (along the x-axis) that would be needed to achieve different levels of power (along y-axis) for each scenario presented above. Based on the current sampling design of 40 samples in the Forebay, the power for the three scenarios ranges from approximately 80 to 93%. For comparisons to a reference mean of 63 µg/kg, the proposed sample number should be sufficient to support statistical comparison of the Forebay and reference population. For a comparison to a threshold value of 100 µg/kg, increasing the sample number to 50 to 60 samples would provide more power. However, these curves were generated based on a two-way comparison and a comparison to a threshold value would likely be conducted as a one-way comparison. The current sample estimate should be a conservative estimate of sample number for a one-way comparison.

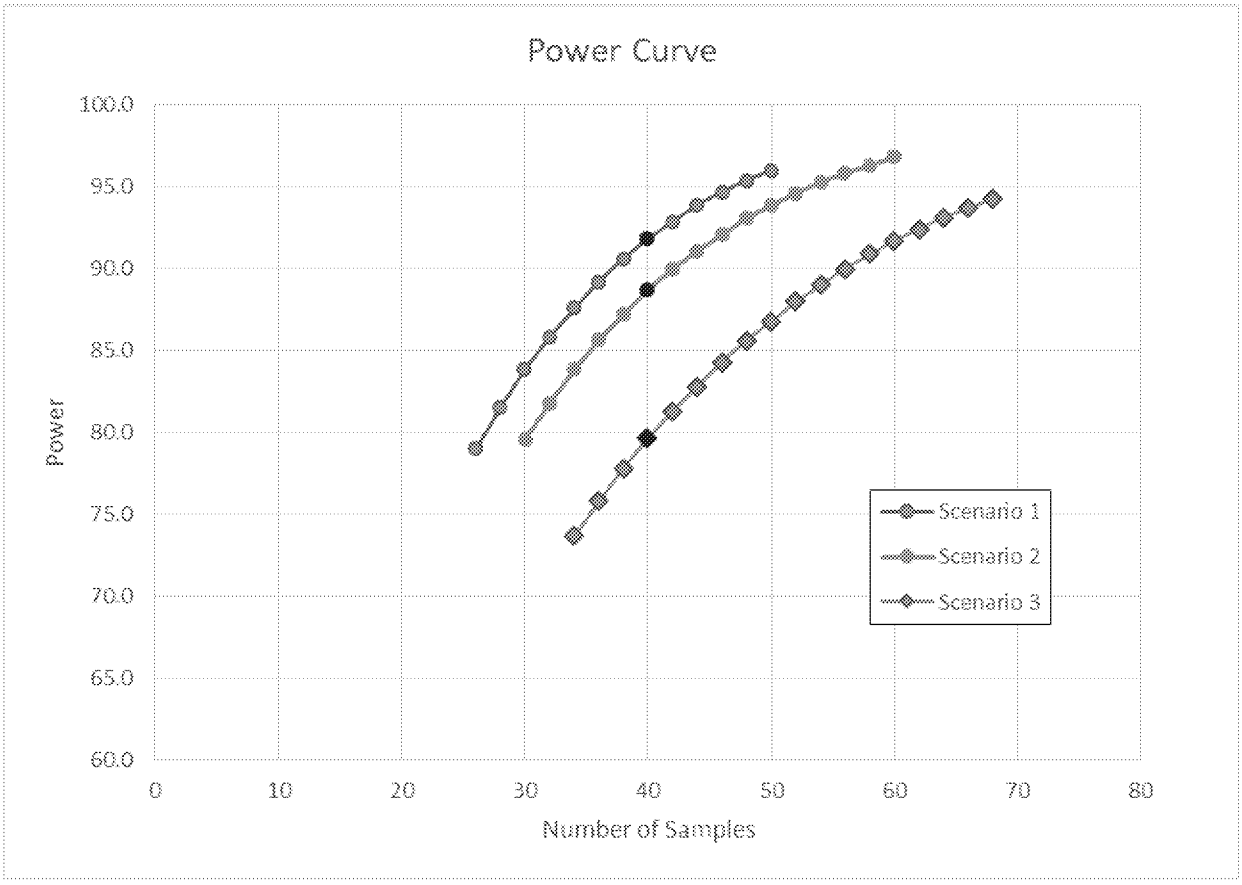

Figure 2. Power Curves for Smallmouth Bass at the Forebay.